Developing an Index of Educational Risk from Health and Social Characteristics Known at Birth

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Abstract. *The goal of the work described in this report was to develop a new child health index that could be reported annually by the National Education Goals Panel for each of the 50 states, as well as for local areas. This index would serve as an indicator of health conditions at birth that relate to children's readiness to learn upon school entry. The new standard birth certificate adopted by nearly all states in 1989 contains more than a dozen items of information that are potentially useful for this purpose. The availability of these data make it possible to sum across the individual health factors to form a composite index made up of factors with demonstrated relevance to later educational performance for all children born in a given year in a given geographical area. In this paper, we describe the development of such an index. Our index consisted of six risk factors: late (third trimester) or no prenatal care, low maternal weight gain (<21 pounds), closely spaced birth (within 18 months of a previous birth to the same mother), three or more older siblings, mother smoked during pregnancy, or mother drank alcohol during pregnancy. In 1990, 55% of all births had none of these risk factors, while 14% had two or more of these risk factors. There were substantial variations by race and ethnicity on this index. American Indian births fared the worst with only 37% of such births having no risks and 28% having two or more risks. Asian births, on the other hand, had the best start on life with 62% of Asian births showing no risks and 11% showing two or more risks. To demonstrate the importance of the index to future school success, we analyzed data from the National Longitudinal Survey of Youth, predicting from birth characteristics to children's reading and vocabulary test scores at ages 4 and 5.*

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Introduction

The work described in this report is rooted in two separate lines of research inquiry. The first influence is the work done on social indicators. During the 1960s and 1970s, policymakers and researchers became interested in developing social indicators that could be used for several purposes including monitoring progress toward national goals and serving as early warning systems for potential problems and unintended side-effects to social programs.[1–4] Such indicators would provide a function similar to economic indicators, such as the Gross National Product, that help to inform policymakers about the state of the economy.

In recent years the use of social indicators has become widespread, as can be seen through almost daily references to crime and drug use rates and to measures such as the infant mortality rate. The popularity of publications such as the Annie E. Casey Foundation's KIDS COUNT volumes further highlights the widespread acceptance and policy relevance of social indicators. The research community also continues to develop and promote the use of social indicators to document trends in different areas of American life;[5] some believe that the education field would benefit from their use.[6] The long-standing interest in social indicators is stimulated in part by major transformations that U.S. society has undergone in recent years and by the fact that the federal government has set goals to be achieved by the end of the century, including the Healthy People 2000 objectives[7] and the National Education Goals,[8] described in more detail below.

The second influence is the work done by psychologists and others on resiliency.[9,10] This line of research has found that individuals recover remarkably well from a variety of stressors, whether they be biological (such as physical illnesses) or social (such as poverty). This work has also found that individuals exposed to multiple risk factors fare much more poorly than individuals exposed to only one risk factor.[10] Recent work in the education field reinforces these findings. Studies show that children from "multiple risk families" may be most in danger of school failure. Researchers have found a linear relationship between a cumulative risk score and measures of verbal IQ and social adjustment in 4-year-old children.[11] These results have led some to speculate that the number of risk factors present in a child's background may be more significant than the nature of the particular risk or risks.[12]

The aim of this work was not to develop an index for screening individual children, but rather to develop an indicator that could be used to track the proportion of children born each year who may be at risk for school difficulties because of their birth circumstances. An important criterion of this indicator was that it could be reported annually by the National Education Goals Panel for each of the 50 states, as well as for local areas.

The National Education Goals

In 1989, President Bush convened the Education Summit with the nation's governors, to discuss why American youth lagged behind other industrialized nations in measures of academic achievement and how to revamp the American educational system so that our youth would be competitive in a world economy. To help focus attention on educational issues, six National Education Goals were adopted by the President and the governors (Exhibit 1). Congress has adopted these goals and added two more in the *Goals 2000: Educate America Act,* which President Clinton signed into law on March 31, 1994.[13] The National Education Goals Panel was created in July 1990 to monitor progress toward the goals over the coming decade.

The goal that we focus on in this paper is the first: *By the year 2000, all children in America will start school ready to learn.* Although there is considerable controversy over what is meant by "ready to learn," the "readiness" goal does remind us that how a child does in school is in part determined by things that have happened before the child ever sets foot in a classroom. The goal recognizes that responsibility for children's readiness does not rest solely with the education system, but also with parents, the health care sys-

Exhibit 1

The Six National Education Goals

Goal 1: *By the year 2000, all children in America will start school ready to learn.*

Goal 2: *By the year 2000, the high school graduate rate will increase to at least 90 percent.*

Goal 3: *By the year 2000, American students will leave grades four, eight, and twelve having demonstrated competency in challenging subject matter, including English, mathematics, science, history, and geography; and every school in America will ensure that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our modern economy.*

Goal 4: *By the year 2000, U.S. students will be first in the world in science and mathematics achievement.*

Goal 5: *By the year 2000, every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship.*

Goal 6: *By the year 2000, every school in America will be free of drugs and violence and will offer a disciplined environment conducive to learning.*

tem, and the social welfare system. The importance of these other forces in children's lives are explicitly recognized in the objectives for Goal 1, in which parents, prenatal care, health care, and proper nutrition are stressed (Exhibit 2).

The National Education Goals Panel and the Goal One Resource Group on School Readiness have struggled with ways to measure achievement toward the first goal. There is agreement that the concept of readiness includes several domains of child

Exhibit 2

The First National Education Goal and its Objectives

Goal 1: *By the year 2000, all children in America will start school ready to learn.*

- All disadvantaged and disabled children will have access to high quality and developmentally appropriate preschool programs that help prepare children for school.
- Every parent in America will be a child's first teacher and devote time each day to helping his or her preschool child learn; parents will have access to the training and support they need.
- Children will receive the nutrition and health care needed to arrive at school with healthy minds and bodies, and the number of low-birthweight babies will be significantly reduced through enhanced prenatal health systems.

development, including physical, emotional, social, and intellectual development. The panel has endorsed the idea of an Early Childhood Assessment System that would collect information about a nationally representative sample of children. In addition to this assessment system, which will not be operational for several years, the panel was interested in monitoring health factors at birth that are associated with longer-term health and development problems, and eventual difficulties in school.

The revised standard birth certificate, adopted by nearly all states as of 1989, contains more than a dozen items of information that are potentially useful in developing an index of educational risk for a group of children born in the same year. These include: whether and when the mother received prenatal care; the amount of weight she gained during pregnancy; whether she smoked cigarettes or drank alcohol during pregnancy; how closely the infant's birth followed a previous live birth to the same mother; the mother's parity (i.e., the number of live-born children the mother already had); and the infant's birth weight and prematurity status. Two of these items—birth weight and prenatal care—are explicitly addressed in the third objective of Goal 1, which states that "the number of low-birthweight babies will be significantly reduced through enhanced prenatal health systems."[8] In addition, the birth certificate contains information on the mother's educational attainment, age, and marital status at birth.

The availability of the new birth certificate data makes it possible to develop a composite index of educational risk for all children born in a given year in a given geographical area. In this article, we describe the development of one indicator and provide a demonstration of its importance through analyses of data from the National Longitudinal Survey of Youth (NLSY), predicting from the birth characteristics of individual children the math, reading, and vocabulary test scores of those same children at ages 4 and 5.

Developing the Index

We initially selected 14 items from the birth certificate for possible inclusion in the index. After reviewing them, we divided them into three groups or clusters of risks: social risks, maternal risks, and infant risks (Exhibit 3). The risks that we ultimately used had to meet three criteria. First, they had to have a direct association with children's subsequent health and development. Second, they had to be modifiable by the individual and by public policy initiatives. Thus, minority membership could not be a risk factor because it is an inherent characteristic of the individual. Third, they could not duplicate information that the Goals Panel was already using. Although the items listed under social risks are important for educational success, they are only indirectly related to children's health and development. Moreover, we had used them in an index of vulnerable family formation that was reported

Exhibit 3

Potential Social and Health Risks at Birth

Social Risks

- Low maternal education
- Unmarried at the time of the birth
- Young maternal age at birth

Maternal Risks

- Birth was closely spaced to previous live birth
- Low maternal weight gain during pregnancy
- Mother smoked cigarettes during pregnancy
- Mother drank alcohol during pregnancy
- High parity
- Mother received prenatal care in third trimester or not at all

Infant Risks

- Premature
- Low birth weight
- Low Apgar score
- Significant complications of labor or delivery
- Multiple birth

in the 1993 KIDS COUNT volume produced by the Center for the Study of Social Policy for the Annie E. Casey Foundation.[14]

The decision, then, was between maternal risk factors and infant risk factors. We chose the former because they are, in fact, the precursors to many of the infants' risks. The incidence of births that are premature, or with low birth weight or low Apgar scores, should decrease as maternal risks decrease.[7] In addition, several of the elements under infant risks (prematurity, significant complications of labor or delivery, and multiple births) are less easily modifiable by the individual or by policy initiatives. Furthermore, the proportion of children born with low birth weights was already being used as an indicator by the National Education Goals Panel.

We defined the risks as: low maternal weight gain (mother gained less than 21 pounds during the pregnancy); mother smoked cigarettes during the pregnancy; mother drank alcohol during the pregnancy; a closely spaced birth (that is, a birth that occurred within 18 months of a prior birth); the mother was parity 4 or higher (that is, she had already had 3 or more live born children); and the mother received prenatal care in the third trimester or not at all.[†]

Previous research has shown that each of these risk factors has potentially adverse effects on children's cognitive development and educational success. Heavy alcohol consumption by itself during pregnancy can cause developmental delays.[15] In the extreme case, it causes fetal alcohol syndrome. Research also suggests, however, that even moderate amounts of prenatal exposure to alcohol can cause learning difficulties.[16] Studies have also shown that closely spaced births and large family size are associated with lower academic achievement.[17–20] Low maternal weight gain, lack of prenatal care, smoking, and alcohol consumption during pregnancy also increase the likelihood of having a low-birth-weight infant.[15,21–23] Not only are low-birth-weight infants at higher risk for morbidity and mortality than normal-weight infants, they also have a greater risk of developmental delays and learning disabilities at older ages, factors that can affect their school success.[24,25]

Quality of Birth Certificate Data for Items in Index

Birth certificate data are widely used by researchers, particularly to monitor and study maternal and child health. For this reason, the National Center for Health Statistics (NCHS) periodically

† Although information on the timing of prenatal care is routinely reported in the Goals Panel reports, emphasis is placed on the initiation of prenatal care in the first trimester.

performs methodological evaluations to assess the quality of the data it collects. An important issue is the validity of the data collected on birth certificates. That is, how accurate a picture of reality do birth certificate data provide? One way to assess the validity of birth certificate data is to compare data derived from the birth certificate with data collected from surveys that have been linked to the birth certificate data. NCHS has conducted two such surveys in the last 15 years: the 1980 National Natality Survey (NNS) and the 1988 National Maternal and Infant Health Survey (NMIHS). Health researchers are also interested in validating birth certificate data and have conducted studies that compare such data with hospital records.[26] Although such comparisons cannot definitively answer which source provides the "truest" measure, agreement between the different sources suggests that the quality of the data are good and disagreement indicates potentially problematic items. Below, we briefly summarize the results of the methodological studies as they pertain to the items we use in our index. We also provide information on the level of missing information for each item, another measure of the quality of the data.

Low maternal weight gain (gaining less than 21 pounds during pregnancy). This item was added to the revised standard birth certificate in 1989. No published comparisons have been made of the level of correspondence between birth certificate data and survey data for this item. It seems reasonable to assume, however, that information collected nearer to the event (i.e., the birth certificate) will be more accurate than information that is collected 1, 2, or even 3 years later.

In 1990, approximately 13% of birth certificates in reporting states had missing data on this item, an improvement over the 17% with missing data in 1989.

Mother smoked cigarettes during pregnancy. The quality of the reported data on amount of smoking during pregnancy appears to be good. It compares well with reports from the 1988 National Maternal and Infant Health Survey and missing data are not a large problem. In 1989, approximately 8% of the states that collected information on maternal smoking had missing information for this item. In 1990, the proportion with missing information for this item had been reduced to about 4%.

Mother drank alcohol during pregnancy. In 1989, as with the data on smoking cigarettes, approximately 8% of the birth certificates in reporting states had missing information on maternal drinking during pregnancy. By 1990, the proportion with missing information had been reduced to approximately 4%.

In both years, however, there appears to be substantial underreporting of alcohol consumption. The women were asked if they drank alcohol during pregnancy, and, if so, the number of drinks per week that they consumed. It may be that women who drank less often than weekly did not report themselves as drinking during pregnancy. The quality of reporting on this item also varies by state. For example, Massachusetts appears to have interpreted this item more as NCHS intended. Thus, Massachusetts has a higher proportion of mothers who report drinking during pregnancy.

In 1990, approximately 3.3% of the births were to mothers who said that they drank alcohol during pregnancy. We obtained a similar figure for the NLSY, for women who reported consuming, on average, 1 or more drinks per week during pregnancy. Data from the NLSY and other studies indicate that the true proportion of women who consume any amount of alcohol during pregnancy is closer to 20%. Even with the underreporting, however, the data show a strong association with an infant's birth weight. Women who report drinking are more likely to have low-birth-weight infants, and the proportion increases as the frequency of drinking increases.

Closely spaced birth (born within 18 months of a prior live birth). NCHS usually defines interval since last live birth (and, therefore, closely spaced births) for second- or higher-order births only. For the purposes of the index, however, first-born children were automatically defined as not closely spaced. For multiple births, the children were defined as closely spaced to a previous live birth.

Piper and her colleagues[26] found substantial agreement (99%) between hospital records and birth certificate data on children's birth dates and on the number of children who survived and who have died. Although they did not compare the two sources for agreement on spacing, the high comparability on the component variables for estimating spacing suggests that these data are quite good.

For the past several years, there has been no change in the distribution of births by birth interval. In 1990, as in 1986–1989, approximately 13% of second- and higher-order births were born within 18 months of a previous live birth. In 1991, the proportion of second- or higher-order births that were closely spaced increased to 14%.

Three or more older siblings. One study that linked survey data to birth certificate data found that the level of agreement between the two sources exceeded 95% for the first birth and decreased with increasing birth order to an agreement rate of 77% for white births and 70% for black births at the fourth and higher birth orders.[27] The same study found that birth certificate data are more likely than survey data to report a high birth order. As noted above, it is not clear which source provides a more accurate picture of reality. Piper and her colleagues, on the other hand, in comparing birth records and hospital data from Tennessee, found substantial agreement between the two on birth order (>99%).

Late or no prenatal care (receiving prenatal care in the third trimester or not at all). The amount of missing data on this item is small in the majority of states. For the nation as a whole, only 2.2% of birth records had missing information on this item.[28] More problematic, however, is the lack of agreement between survey data and birth certificate data on this item. Only a third of records from the 1988 NMIHS that were matched with birth certificate data agreed that prenatal care began in the third trimester or not at all.[27] However, the NMIHS oversampled low-birth-weight infants. Although weights were used to adjust for the oversampling, the data may still not be representative of the population as a whole for all measures. It is very possible that the survey data are not as accurately reported for this population. Moreover, up to 3 years elapsed between the birth and the maternal interview. Thus, it is also possible that the mother was referring to a different birth than the one intended on the interview.

From a social policy point of view, it is important to know what fraction of the population is free of any risk factors and what proportion are more vulnerable because they experience several risk factors. Although illuminating, reporting single risks such as low birth weight reveal nothing about the extent of overlap among risk factors. In spite of the fact that not all the individual components of our index are equally well-measured, from a social policy point of view even imperfect measures can be quite telling at the social group level.

Constructing the Index from Birth Certificate Data

To construct the index using the birth certificate data, we created dummy variables for each of the six factors where 0 was defined as no risk and 1 as having the risk at birth. We then summed the number of risks. This procedure gives the same weight to each item in the indicator. Although an optimally weighted scale might have a slightly higher reliability and correlation with criterion measures than the one we have constructed, research suggests that equally weighted scales correlate quite highly with alternative methods of constructing scales and that the loss in reliability is usually slight.[29] Moreover, the approach has the advantage of being simple to apply, with a clear underlying logic.

In order not to eliminate cases that had missing information on only a few of the items, we allowed cases to be included in the calculation if they had two or fewer pieces of missing information. Any case that had three or more pieces of missing information was excluded from the analyses.

After obtaining the straight count of risks for the nation as a whole and for each of the states that had the necessary data, we transformed the index to indicate the presence of no risks, one or

TABLE I
PROPORTION OF BIRTHS BY NUMBER OF RISK FACTORS* AT BIRTH, 1990

	Number of Births†	No Risks (%)	1 or More (%)	2 or More (%)	3 or More (%)
United States	2,997,963	55	45	14	4
White (non-Hispanic)	2,061,603	57	43	12	3
Black (non-Hispanic)	527,609	46	54	21	7
Hispanic	278,295	54	46	14	3
Asian	67,158	62	38	11	3
American Indian	28,631	37	63	28	9

Note: Excludes the following states:
California (does not obtain information on smoking, drinking, or weight gain)
Indiana (does not obtain information on smoking)
New York (does not obtain information on smoking or drinking)
Oklahoma (does not obtain information on smoking, drinking, weight gain, or Hispanic origin)
South Dakota (does not obtain information on smoking or drinking)
New Hampshire is included in the US total, but not in the race/ethnic totals because New Hampshire does not collect information on Hispanic origin.
Source: Christine Winquist Nord and Nicholas Zill, Westat, Inc. Special tabulations of 1990 US birth certificate data.
* Risks are: late (in third trimester) or no prenatal care; low maternal weight gain (<21 pounds); closely spaced birth (within 18 months of previous birth); three or more older siblings; mother smoked during pregnancy; or mother drank alcohol during pregnancy.
† The number of births used to calculate the risk index, not the actual number of births within each group. See note for states that were excluded. If any birth record was missing three or more pieces of information needed to calculate the index, that case was excluded from the calculation.

more, two or more, or three or more risks. It was this indicator that appeared in the 1993 Goals Panel Report and is shown in Tables I and II.

Results Based on 1990 Birth Certificate Data

As can be seen in Table I, 45% of all children born in the United States in 1990 had one or more risk factors present at birth, 14% (or one of every seven births) had two or more risks, and 4% had three or more risks. There was substantial variation by race and ethnicity. Asian children had the best start on life: 38% had one or more risks. American Indian children were the most disadvantaged on this index: 63% had one or more risks at birth, and 9% had three or more risks.

The single most common risk factor is low maternal weight gain. Over one-third of the children with one or more risk factors have low maternal weight gain as one of their risks. Nearly one-quarter

TABLE II
INDICATOR OF EDUCATIONAL RISK: REPORTING STATES,* 1990

Total Births	Births Used in Index	Births in Index (%)	State	Births with risk factors (%) None	One or More	Two or More	Three or More
63,487	63,216	99.6	Alabama	54	46	14	4
11,902	11,830	99.4	Alaska	52	48	18	5
68,995	68,339	99.0	Arizona	51	49	17	4
36,457	36,179	99.2	Arkansas	51	49	16	4
53,525	52,489	98.1	Colorado	58	42	13	3
50,123	35,927	71.7	Connecticut	67	33	8	2
11,113	11,042	99.4	Delaware	52	48	15	4
11,850	11,659	98.4	District of Columbia	45	55	23	9
199,339	198,794	99.7	Florida	54	46	15	4
112,666	111,826	99.3	Georgia	57	43	14	4
20,489	20,301	99.1	Hawaii	60	40	11	3
16,433	15,884	96.7	Idaho	51	49	16	4
195,790	195,470	99.8	Illinois	55	45	14	4
39,409	39,350	99.9	Iowa	53	47	15	3
39,020	38,754	99.3	Kansas	58	42	12	3
54,362	52,149	95.9	Kentucky	49	51	17	4
72,192	72,027	99.8	Louisiana	52	48	16	4
17,359	17,305	99.7	Maine	58	42	12	2
80,245	60,632	75.6	Maryland	61	39	11	3
92,654	92,431	99.8	Massachusetts	51	49	20	5
153,700	149,250	97.1	Michigan	53	47	15	4
68,013	64,842	95.3	Minnesota	62	38	12	3
43,563	43,357	99.5	Mississippi	51	49	15	4
79,260	78,850	99.5	Missouri	52	48	16	4
11,613	11,574	99.7	Montana	53	47	17	5
24,380	24,341	99.8	Nebraska	53	47	15	4
21,599	21,265	98.5	Nevada	52	48	16	4
17,569	17,528	99.8	New Hampshire	58	42	12	3
122,289	116,921	95.6	New Jersey	62	38	11	3
27,402	26,971	98.4	New Mexico	53	47	15	4
104,525	104,206	99.7	North Carolina	54	46	15	4
9,250	9,209	99.6	North Dakota	55	45	14	4
166,913	166,434	99.7	Ohio	51	49	16	4
42,891	42,614	99.4	Oregon	52	48	16	4
171,961	170,723	99.3	Pennsylvania	54	46	15	4
15,195	14,983	98.6	Rhode Island	56	44	13	3
58,610	58,498	99.8	South Carolina	50	50	16	4
74,962	74,873	99.9	Tennessee	55	45	14	3
316,423	283,669	89.6	Texas	58	42	12	3
36,277	36,139	99.6	Utah	53	47	13	2
8,273	8,151	98.5	Vermont	56	44	14	3
99,352	97,215	97.8	Virginia	58	42	12	3
79,251	68,623	86.6	Washington	57	43	13	3
22,585	22,382	99.1	West Virginia	51	49	16	4
72,895	72,782	99.8	Wisconsin	49	51	18	5
6,985	6,959	99.6	Wyoming	50	50	17	4
4,158,212	2,997,963	72.1	US TOTAL	55	45	14	4

Source: Christine Winquist Nord and Nicholas Zill, Westat, Inc. Prepared for the National Education Goals Panel using 1990 natality data.

* The following states did not obtain information on some or all of the risk factors: California, Indiana, New York, Oklahoma, and South Dakota.

of the children born with at least one risk factor have low maternal weight gain as their only risk. Smoking during pregnancy is the second most common risk factor, followed by births to women with three or more children and closely spaced births.

States vary in their level of risk (Table II). In four states—Kentucky, South Carolina, Wisconsin, and Wyoming—and the District of Columbia, at least 50% of the children were born with one or more risk factors. Among the states that used at least 98% of the births to calculate the indicator, Hawaiian babies had the fewest risks at birth: 60% were born with no educational risk factors. Hawaii's health care system may be helping to ensure that their children have a good start on life.

Some caution should be used in making state comparisons because of differences in the levels of missing data and in the quality of reporting. Although in most states the index was based on 98% or more of the births occurring in the state, some states had problems with missing data on the necessary items. For example, the index was based on only 76% of the births in Maryland and 72% of the births in Connecticut. Also, as noted earlier, Massachusetts appears to have obtained better-quality reporting of alcohol consumption during pregnancy and thus has more births classified with one or more risks than some other states, whose quality of reporting may not be as good. As states become familiar with the new items, however, the quality of the items in the different states should become more similar and, therefore, future state comparisons will be more appropriate.

Significance of the Index

To assess the importance of the risks at birth for the educational success of children at school entry, we analyzed data from the 1986, 1988, and 1990 child files of the NLSY, predicting from birth characteristics to children's vocabulary, reading, and math scores at ages 4 and 5. In particular, we examined the scores of 4- and 5-year-olds on the Peabody Picture Vocabulary Test (PPVT) and the scores of 5-year-olds on the Peabody Individual Achievement

Test for Mathematics (PIAT-MATH) and the Peabody Individual Achievement Test of Reading Recognition (PIAT-RR). These latter two tests were not given to children younger than 5 years of age. The PPVT measures children's vocabulary for standard spoken English and provides a quick estimate of verbal ability. The PIAT-MATH measures children's knowledge of mathematics. The PIAT-RR measures word recognition and pronunciation ability. All of these tests are highly correlated with how well children do in school.

The NLSY Sample

The NLSY is a longitudinal survey of youth who were ages 14 to 21 years of age in 1979. These youth have been interviewed annually through the present. As of 1990, the NLSY respondents were 25 to 32 years of age. In 1986, 1988, and 1990 all children born to the female NLSY respondents were assessed. Because the NLSY respondents are a still-youthful cohort, the mothers in the NLSY tend to be younger than would be the case in a representative household sample. For example, 4- and 5-year-olds in 1986 were born to women aged 16 to 24 at the time of the birth, 4- and 5-year-olds in 1988 were born to women 20 to 28, and 4- and 5-year olds in 1990 were born to women 22 to 30.

To increase the sample size and to increase the proportion of children born to mothers in their twenties, we combined data for all appropriate aged children in each of the three years. There were 3,178 children aged 4 to 5 years old in the pooled data set. Although information was combined from three separate years, data for a particular child only appears once in the combined data (i.e., children who were 4 or 5 in one year would not be the appropriate age in any other year).

We used NLSY data to create variables that were parallel to the information contained on the birth certificate. Because the drinking item on the birth certificate appears to obtain data for women who drank weekly during pregnancy, we defined the drinking item in our NLSY analyses as consuming one or more drinks per week. Smoking was defined as a pack of cigarettes or more per day because the NLSY did not obtain information on the actual number of cigarettes smoked per day. Although we originally requested that the actual index be based on this definition of risk, NCHS staff were uncomfortable with even indirectly suggesting that *any* smoking during pregnancy was all right. Therefore, as noted above, for the actual index based on the birth certificate data, the risk from smoking was defined as any smoking during pregnancy.

Results of NLSY Analyses

The NLSY children who were 4 or 5 years old had been exposed to somewhat fewer risks than the births that occurred in 1990. Whereas 45% of children born in 1990 had one or more risk factors present at birth, 41% of 4- or 5-year-old children in the NLSY had one or more risk factors at birth. It is likely that the truncated age span of the mothers limits the number of mothers who have had three or more children. Moreover, more of the children in the NLSY are first borns than in the population at large. Therefore, it is likely that fewer of the children in the NLSY are closely spaced to a prior birth than in a cohort of newborns. Finally, we defined smoking more stringently in the NLSY analyses than in the index based on the birth certificate, which would also contribute to a lower count of risks.

Our analyses revealed that an increase in the index was associated with a decrease in mean test scores for all three tests at ages 4 and 5 (Fig. 1). For example, the mean score on the PPVT for children with no risk factors at birth was 94 compared to a mean score of 77 for children with three or more risk factors at birth. Similarly, the mean score on the PIAT-MATH for children with no risk factors was 101 compared to a mean score of 90 for children with three or more risk factors at birth.

Several of the maternal risk factors we used are known to be strongly associated with low birth weight.[30] We examined the correlations between each of our variables and between them and low birth weight. None of the correlations exceeded .10 and most

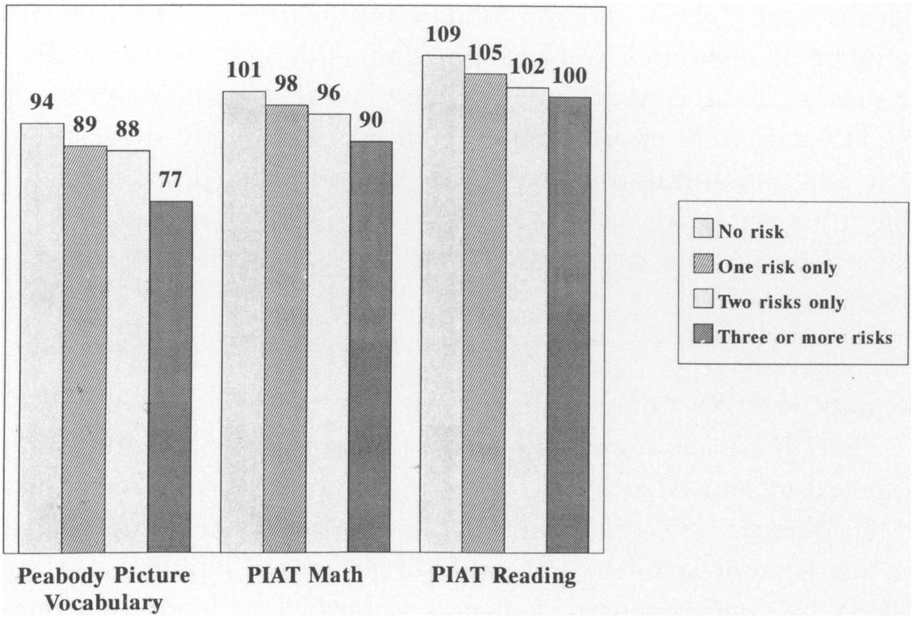

FIG. 1. Mean test scores at ages 4 and 5 by presence of risk factors at birth.

of the correlations were well below that.‡ In addition, we performed several analyses (not shown) to determine whether our index remained significant in predicting children's cognitive test scores even after low birth weight was entered into the models. Entering low birth weight into the equations did not materially alter the parameter estimates or the significance levels of any of the risk factors that comprised our index.

To further examine the robustness of the association between the maternal risks at birth and the children's scores on these three tests, we estimated a series of ordinary least squares regression models, controlling for variables that could be associated with both the indicator and the children's test scores. To account for the complex sampling design, appropriate weights were used. The results from these regressions are summarized in Table III.

The coefficients may be interpreted as the change in the test

‡ Maternal weight gain and closely spaced births showed the strongest association with low birth weight, with Pearson correlation coefficients of .097 and .102, respectively. Smoking showed the next highest correlation, with a coefficient of .056.

TABLE III
PREDICTED DECLINE IN CHILDREN'S TEST SCORES PER UNIT INCREASE IN THE HEALTH RISK INDEX*

		PPVT: 4- and 5-year-olds	PIAT-MATH: 5-year-olds	PIAT-RR: 5-year-olds
A.	Indicator with no controls	−4.5† (.477)	−3.0† (.497)	−3.6† (.483)
B.	Indicator controlling for race, Hispanic origin, and sex of child	−3.6† (.418)	−2.7† (.486)	−3.5† (.478)
C.	Indicator controlling for variables in B., plus: mother was a teenager, had less than a high school education, and was unmarried at child's birth	−2.9† (.422)	−2.2† (.492)	−2.7† (.478)
D.	Indicator controlling for all variables in C., plus mother's score on the Armed Forces Qualifying Test	−2.2† (.406)	−1.7‡ (.477)	−2.2† (.458)

Source: Christine Winquist Nord and Nicholas Zill, Westat, Inc. Analyses of the 1986, 1988, and 1990 Child Supplements to the National Longitudinal Surveys of Youth.
* Standard errors appear in parentheses below the regression coefficients.
† Significant at .0001 level.
‡ Significant at .001 level.

scores for each unit change in the indicator. Because the indicator is a simple sum of the number of risks present at birth, the regression coefficients indicate the change in test scores for each additional risk at birth. Row A of Table 3 shows the regression coefficient of the indicator when it is regressed with no controls on the three tests. Row B regresses the indicator on children's test scores, controlling for whether the mother was black or of Hispanic origin and the child's sex. Row C controls for these variables as well as whether the mother was a teenager at the time of the birth, had less than a high school education at the time of the birth, and was married at the child's birth. Row D of Table III controls for all of the variables in Row C as well as for the mother's score on the Armed Forces Qualifying Test (AFQT). The AFQT is a measure of the mother's intellectual ability.

Even after controlling for all these factors, the indicator of maternal risks at birth remains a significant predictor of 4- and 5-year-old children's scores on the PPVT, the PIAT-MATH, and the PIAT-RR. For both the Peabody Picture Vocabulary Test and the PIAT Test of Reading Recognition, there is more than a two-point decline in the children's test scores for each increase in risk. For the PIAT-MATH, there is just under a two-point decrease in their test scores for each increase in risk. The risks included in the health index are still affecting the children's lives 4 and 5 years after their births.

Discussion

The educational risk indicator we have constructed highlights how often children are exposed to preventable risks. Although the absence of any risks does not guarantee that a child will be well-prepared for the challenges of formal schooling, children with no risks are, on average, in a better position to do well in school than are those children having one or more risk factors. Similarly, not all children born with one or more risks have problems when they enter school, yet the risks make it more likely that this will be the case. As our analyses based on the NLSY demonstrated, even after controlling for important confounding factors such as maternal education, race, ethnicity, and mother's own ability, the maternal risk index remained a significant predictor of test scores that are predictive of school success.

This index can be easily calculated each year for the nation, the 50 states, and for local areas. It gives visibility to the importance of maternal behaviors during pregnancy and prenatal care for children. Tracking it will help in determining whether provision of services and increased awareness help to change parental behaviors and improve children's health and chances for a good beginning in school.

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